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Ophthalmology Lecture 5: Diabetic Eye Disease

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DIABETIC EYE DISEASE

ELWA Family Medicine Residency Program

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OUTLINE

- INTRODUCTION
- EPIDEMIOLOGY
- ANTERIOR SEGMENT EYE COMPLICATIONS OF DM
- DIABETIC RETINOPATHY
- PATHOPHYSIOLOGY
- RISK FACTORS
- MANAGEMENT
- SCREENING

DIABETES MELLITUS

- Diabetes mellitus (DM) is a disease of high blood sugar and disordered carbohydrate, fat and protein metabolism.
- DM causes damage to blood vessels throughout the body.
- The small vessels of the retina are commonly affected. This causes damage to the retina itself and ultimately affects vision.
- In type 1 DM there is autoimmune destruction of the insulin secreting cells in the pancreas causing it to stop producing any insulin.
- Type 1 DM occurs mainly in younger people and requires insulin treatment to reduce blood sugars.
- Type 2 DM is more common and usually occurs in older people. It is often treated with tablets to reduce the blood sugar.
- In type 2 DM there is often a degree of insulin resistance as well as reduced production.

EPIDEMIOLOGY

- Diabetes is a serious, long-term condition with a major impact on the lives and well-being of individuals, families, and societies worldwide.
- The global diabetes prevalence in 2019 is estimated to be 9.3% (463 million people), rising to 10.2% (578 million) by 2030 and 10.9% (700 million) by 2045.
- The prevalence is higher in urban (10.8%) than rural (7.2%) areas, and in high-income (10.4%) than low-income countries (4.0%).
- One in two (50.1%) people living with diabetes do not know that they have diabetes

- Over the last few years both diabetes and diabetic retinopathy have become increasingly common, particularly in low and middle-income countries.
 - *Increased prevalence of obesity*; this predisposes to type 2 diabetes.
 - *Dietary changes*.
 - *Increased life expectancy*: people are living longer in most areas of the world. There are therefore more years in which they might develop diabetes and its complications.
 - *Lifestyle*. Many people are leading increasingly sedentary lifestyles. This leads to weight gain and an increased risk of type 2 diabetes.

- Of an estimated 285 million people with diabetes mellitus worldwide, approximately **one third have signs of DR** and of these, a further **one third of DR is vision-threatening DR, including diabetic macular edema (DME).**
- Diabetic Retinopathy (DR) is the leading cause of vision loss in adults aged 20–74 years
- The identification of established modifiable risk factors for DR such as hyperglycemia and hypertension has provided the basis for risk factor control in preventing onset and progression of DIABETIC RETINOPATHY.

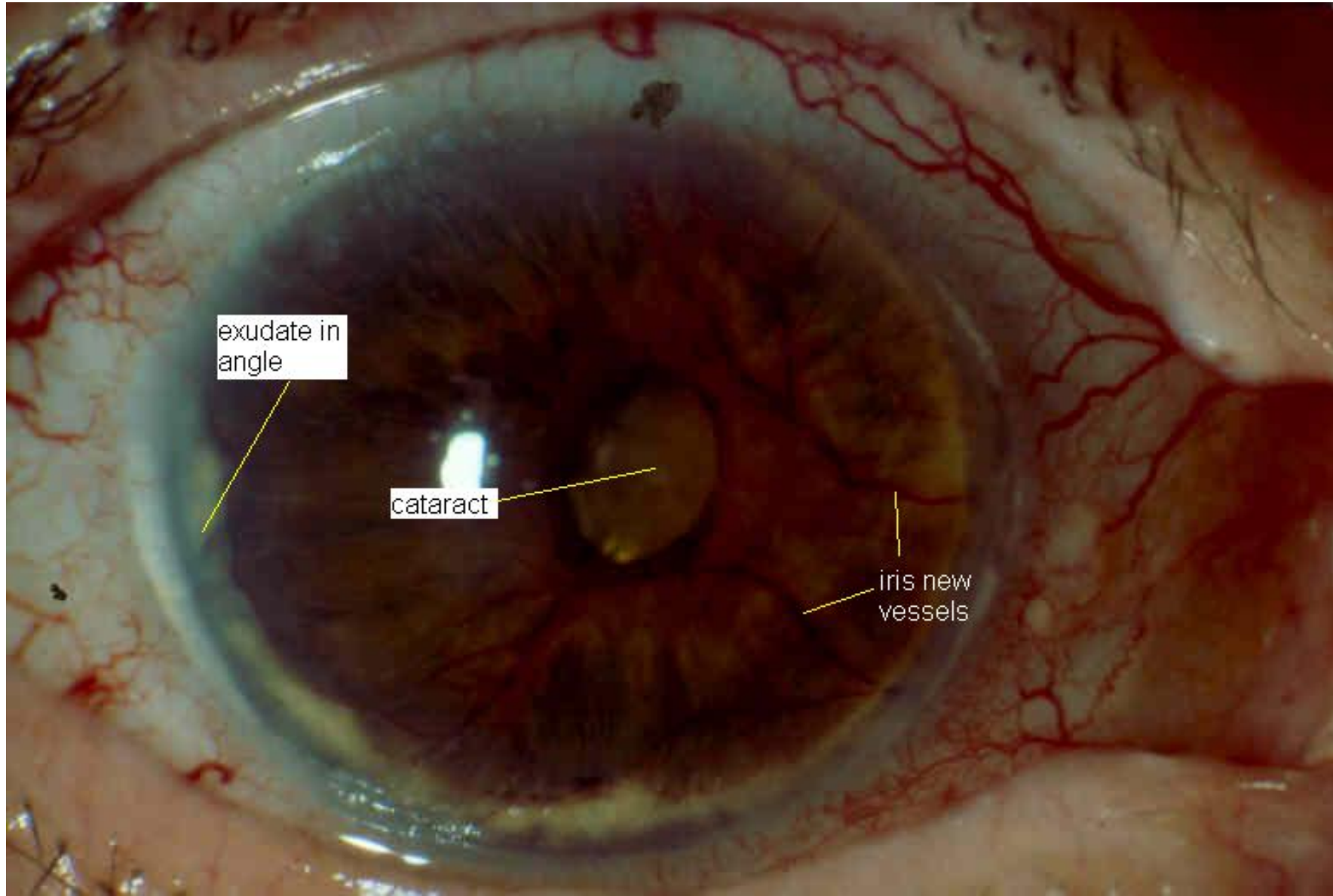
Diabetic Eye Disease Anterior Segment

- Manifest refractive changes
 - ❑ 1.5x more likely to be myopic
 - ❑ Investigate in adult-onset myopia
- Cataract formation
 - ❑ More commonly cortical cataract
- Glaucoma
- IIIrd and VIth cranial nerve palsies
 - ❑ Resolve in 2-6 months
 - ❑ No pupil involvement

Diabetic Eye Disease Anterior Segment

- Recurrent corneal epithelial erosions and reduced corneal sensitivity
- Blepharitis, stytes and chalazion
- Rubeosis Iridis
 - ☐ Sign of advanced diabetic eye disease
 - ☐ Growth starts at pupil margin
 - ☐ Leads to acute ACG

Iris new vessels



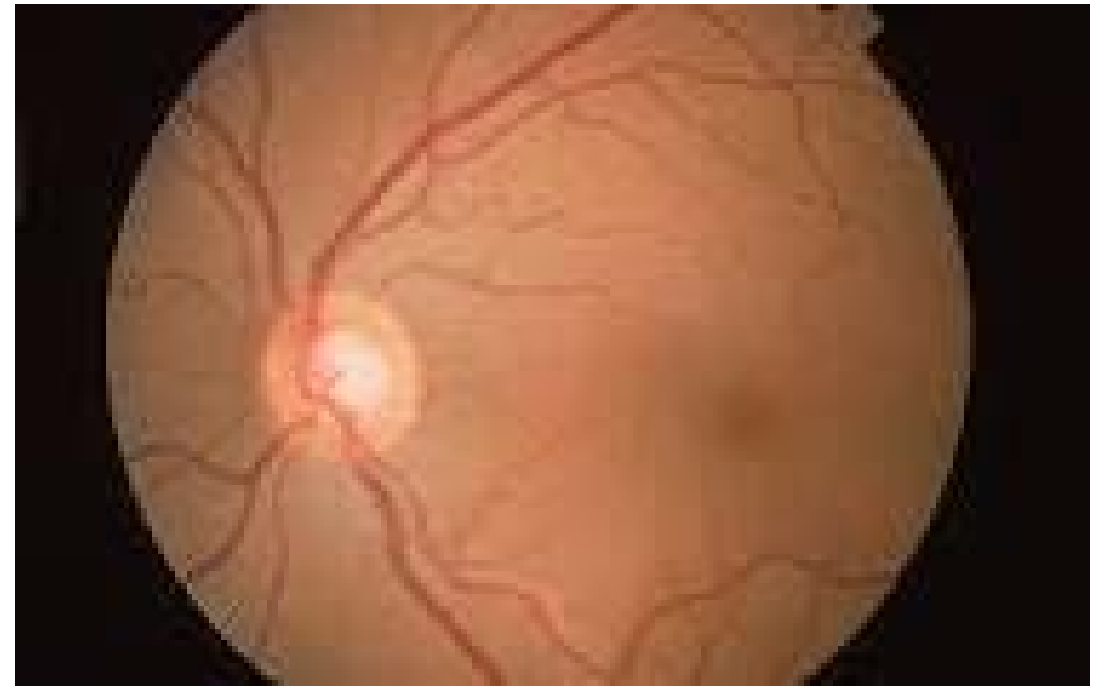
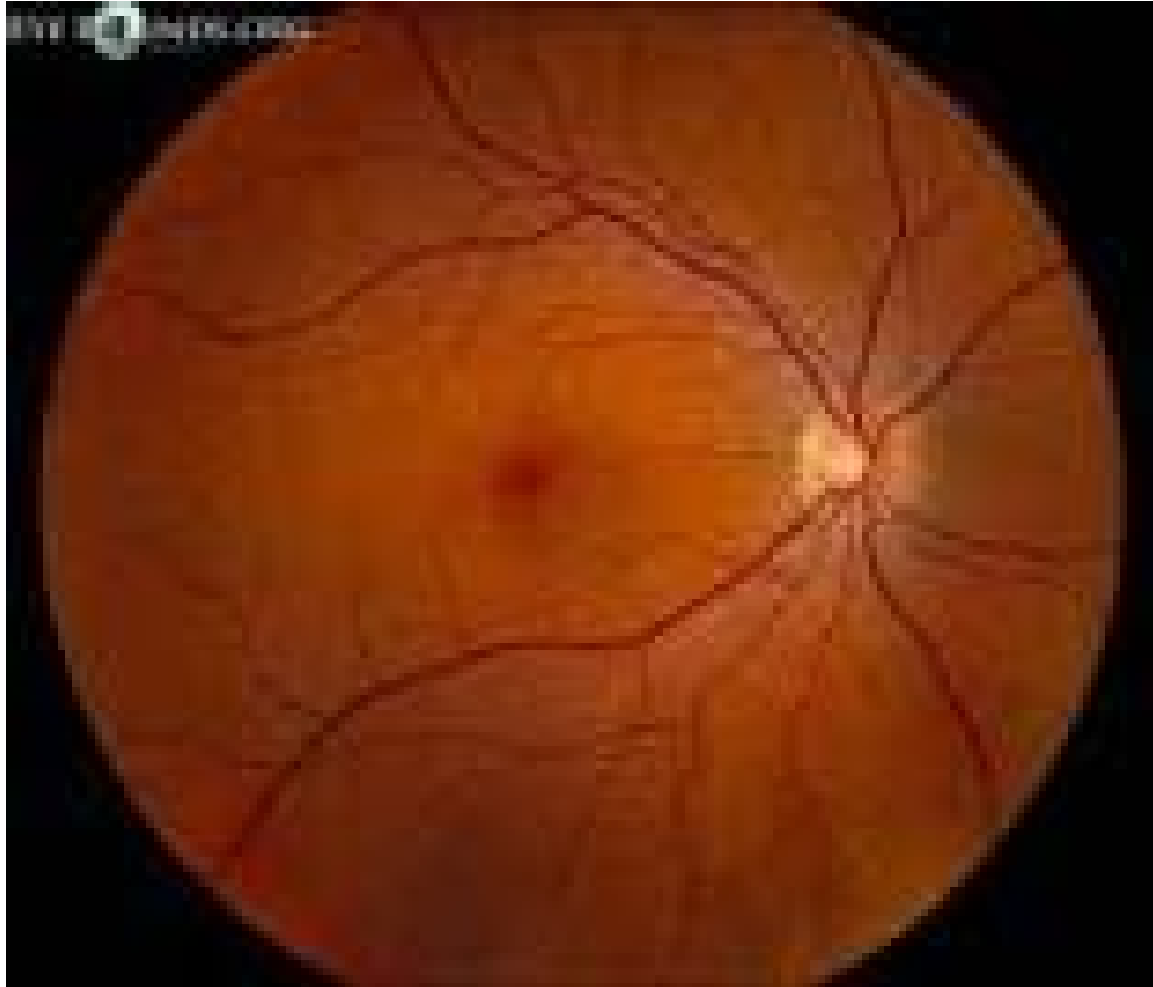
DIABETIC RETINOPATHY

NORMAL FUNDUS

- The eye is an excellent window through which the blood vessels and blood circulation in the body can be seen.
- The retinal circulation can be seen in great detail with the direct ophthalmoscope, which gives an image of the retina and its blood vessels about 15 times larger than their actual size.
- Some ophthalmoscopes also have a green filter in them. This is very useful because it makes the retinal blood vessels and any blood that has leaked in the retina much more obvious.

- The normal fundus should have no visible haemorrhages or patches of exudate and the presence of either of these suggests some underlying pathology.
- Vascular disease can cause haemorrhage and exudate anywhere or all over the fundus, but is often particularly concentrated around the optic disc and macula because the retinal blood supply is greatest here.
- Although damage to these areas causes the most visual damage, they are fortunately the easiest areas to examine with an ophthalmoscope.

NORMAL FUNDUS



PATHOPHYSIOLOGY OF DIABETIC RETINOPATHY

- A disease of the retinal microvasculature causing capillary leakage and occlusion
- Larger retinal vessels are located in the NFL and GCL
- Smaller retinal capillaries are located as deep as the INL
- The RPE and the retinal vasculature form the Blood-Retinal barrier
 - Tight junctions
 - No fenestrations
 - Pericytes to control growth and provide support
 - Basement membrane

PATHOPHYSIOLOGY OF DIABETIC RETINOPATHY

- Abnormal changes to the microvasculature
 - Thickening of the basement membrane
 - Loss of pericytes
 - Endothelial cell changes
- Basement membrane effect is accelerated ageing
- 75% pericyte loss removes support and allows bulging of the vessel wall (saccular MA)
- Extra growth of endothelial cells, forming tightloop MAs
- Loss of tight junctions breaks down the bloodretinal barrier

PATHOPHYSIOLOGY OF DIABETIC RETINOPATHY

- Intra-retinal lipid exudates
 - From leakage of plasma proteins and lipoproteins
 - Located in OPL and form streaks or circles around areas of leakage
 - Leakage at macula leads to visible oedema (focal and diffuse)
- Further leakage causes:
 - Intra-retinal haemorrhages
 - Flame-shaped haemorrhages when from superficial capillary bed
 - Dot and blot haemorrhages when from deep capillary bed.

PATHOPHYSIOLOGY OF DIABETIC RETINOPATHY

Capillary blockage due to:

- Thickening of basement membrane
- Sticky endothelial cell
- Increased blood viscosity as platelets aggregate and red blood cells change
- Causes local retinal hypoxia and nerve cell death
- Metabolic debris accumulates in the nerve fibres as axoplasmic transport fails
- This material is located at the edges of ischaemic retina and appears as **cotton wool spots**

PATHOPHYSIOLOGY OF DIABETIC RETINOPATHY

The retinal hypoxic response

- **Vascular endothelial growth factor** is released from veins in areas of retinal hypoperfusion
- Initial response is limited to the capillary bed, in the dilation of pre-existing arterio-venous connections (IRMA)
- Later, outgrowths from the veins begin to grow through the ILM and across the face of the posterior vitreous forming new vessels (PDR)

PATHOPHYSIOLOGY OF DIABETIC RETINOPATHY

New vessels

- Immature, without normal pericytes numbers or tight junctions, but with fenestrations
- Prone to bleeding and leakage
- Accompanied by fibroblasts, forming fibrous attachments between vessels and vitreous
- Fibrous contraction causes:
 - Bleeding
 - Retinal detachment
 - Retinal tears
 - Rhegmatogenous retinal detachment
- VEGF leads to new vessel formation on the iris (rubeosis iridis)

When does Diabetic Retinopathy arise?

- Prevalence of Diabetic Retinopathy:
 - At Diagnosis: 20%
 - 10 years after Diagnosis: 40-50%
 - 20 years after Diagnosis:
 - Type I 100%
 - Type II 60%

Risk factors for diabetic retinopathy

- Poor blood sugar control
- Increased blood pressure
- Increasing number of microaneurysms
- Duration of diabetes
- Protein and albumin in the urine
- Raised cholesterol
- Pregnancy
- Smoking

Table 13.2 A simple classification system for diabetic retinopathy

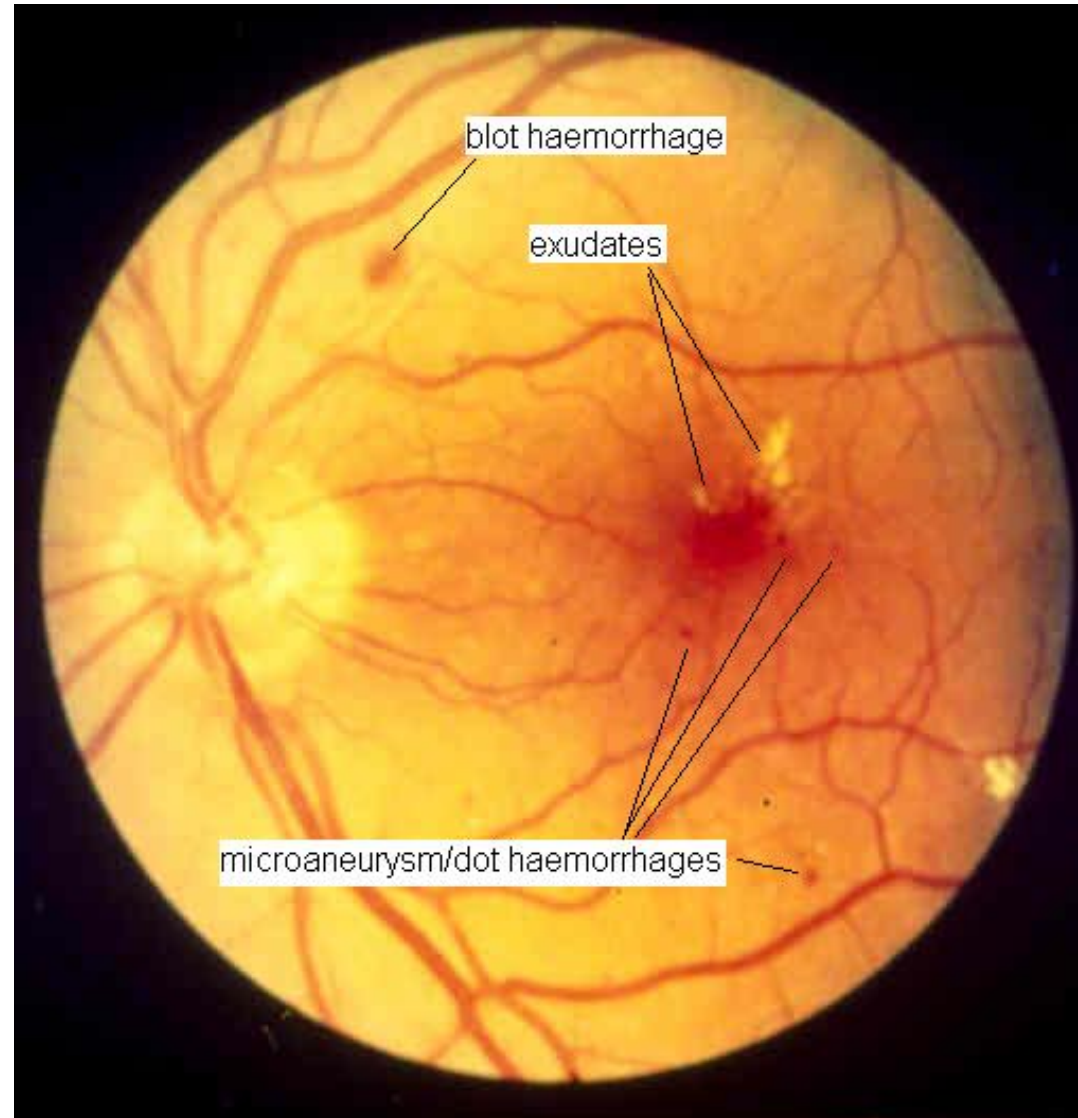
| Type of retinopathy | Key features | Treatment |
|---------------------------------|--|--|
| Background diabetic retinopathy | No new vessels and no severe ischaemic changes | Lifestyle changes (blood pressure, diet etc) and observation only of retina |
| Pre-proliferative retinopathy | Severe ischaemic changes, i.e. lots of deep haemorrhages, cotton wool spots and vessel abnormalities, but no new vessels | Consider panretinal photocoagulation, particularly if patient follow-up may be difficult |
| Proliferative retinopathy | New blood vessels developing at the optic disc or retina | Panretinal photocoagulation |
| Maculopathy | Macular oedema and exudate that is impairing the vision | Macular laser and/or intravitreal anti-VEGF agents. |

Table 13.3 The microvascular changes, fundus changes and sight-threatening complications of diabetic retinopathy

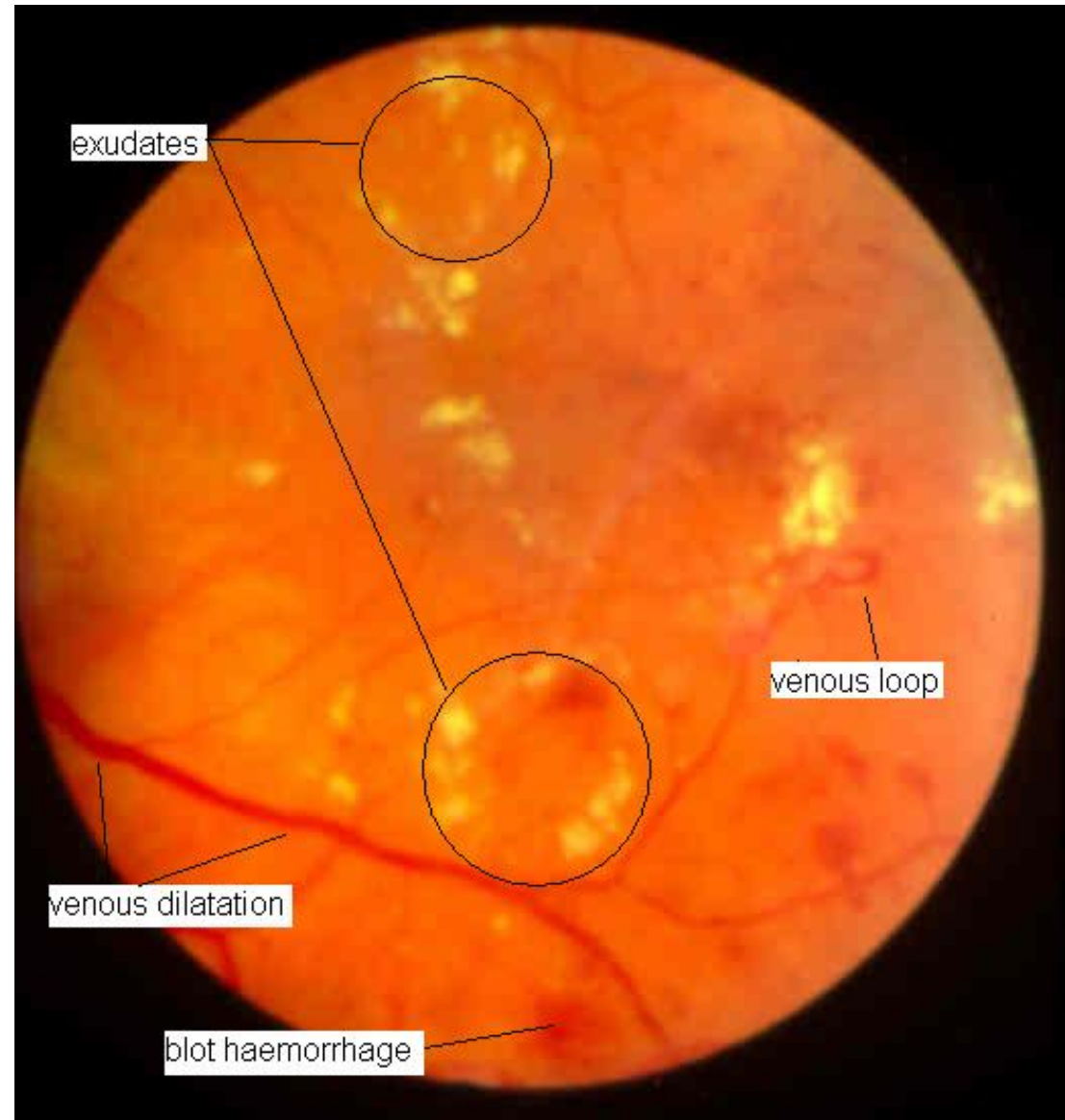
| Two pathological changes | Six clinical abnormalities seen on fundus examination | Four sight-threatening complications |
|--|---|--|
| <p>Capillary closure causing ischaemic areas*</p> <p>Capillary leakage</p> | <p>Microaneurysms</p> <p>Macular leakage</p> <ul style="list-style-type: none"> – Exudate – Oedema <p>Haemorrhages</p> <ul style="list-style-type: none"> – Dot haemorrhages – Blot haemorrhages – Flame haemorrhages <p>Changes in the veins</p> <ul style="list-style-type: none"> – ‘Beading’ and irregularities of the veins – Venous loops – Intra-retinal microvascular abnormalities <p>Cotton-wool spots</p> <p>New blood vessels</p> | <p>Diabetic maculopathy (macular oedema)</p> <p>Proliferative retinopathy (new vessels)</p> <p>Vitreous haemorrhage</p> <p>Tractional retinal detachment</p> |

*Ischaemic areas are best seen on fluorescein angiography (Figure 13.11)

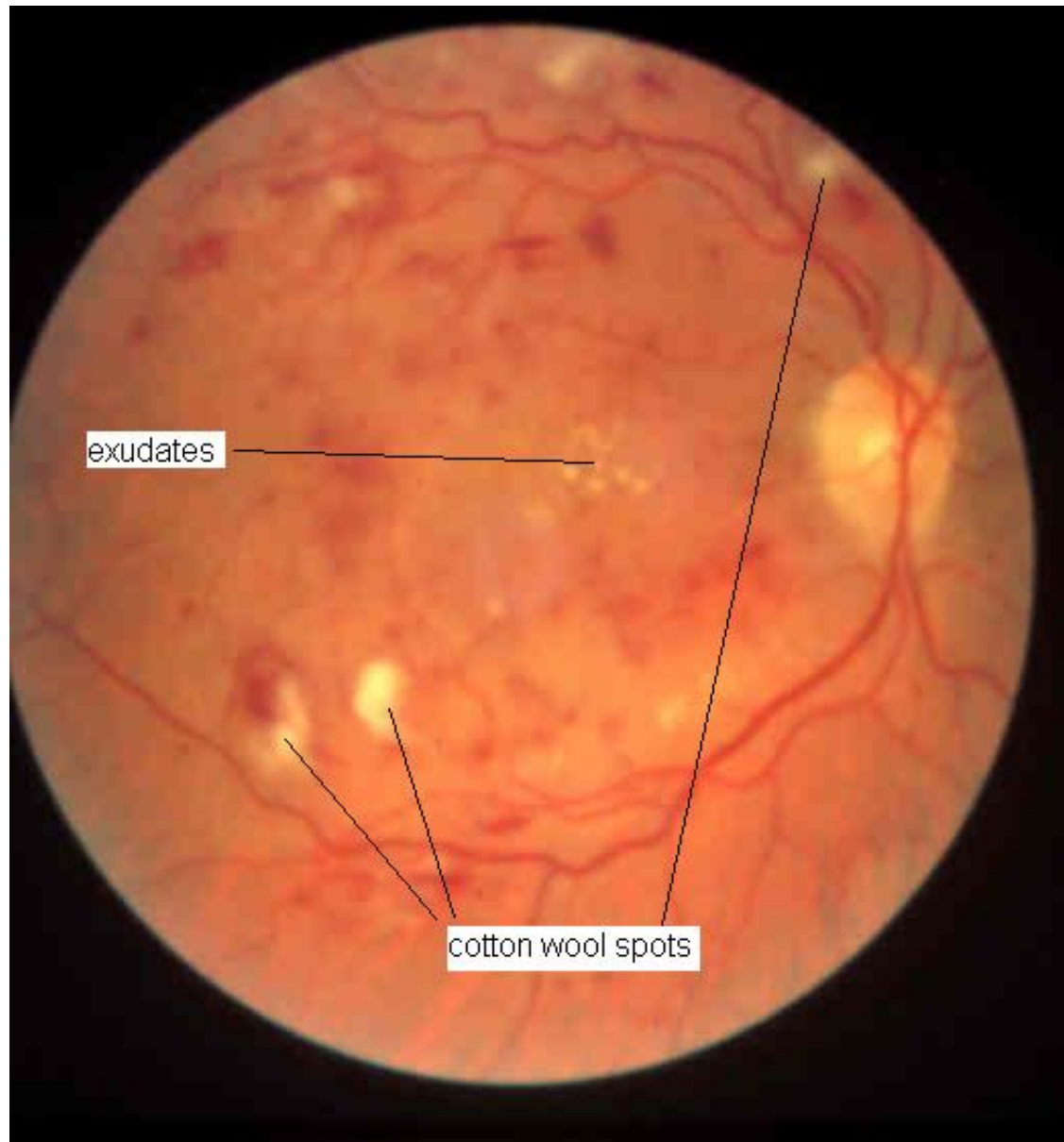
BDR



BDR



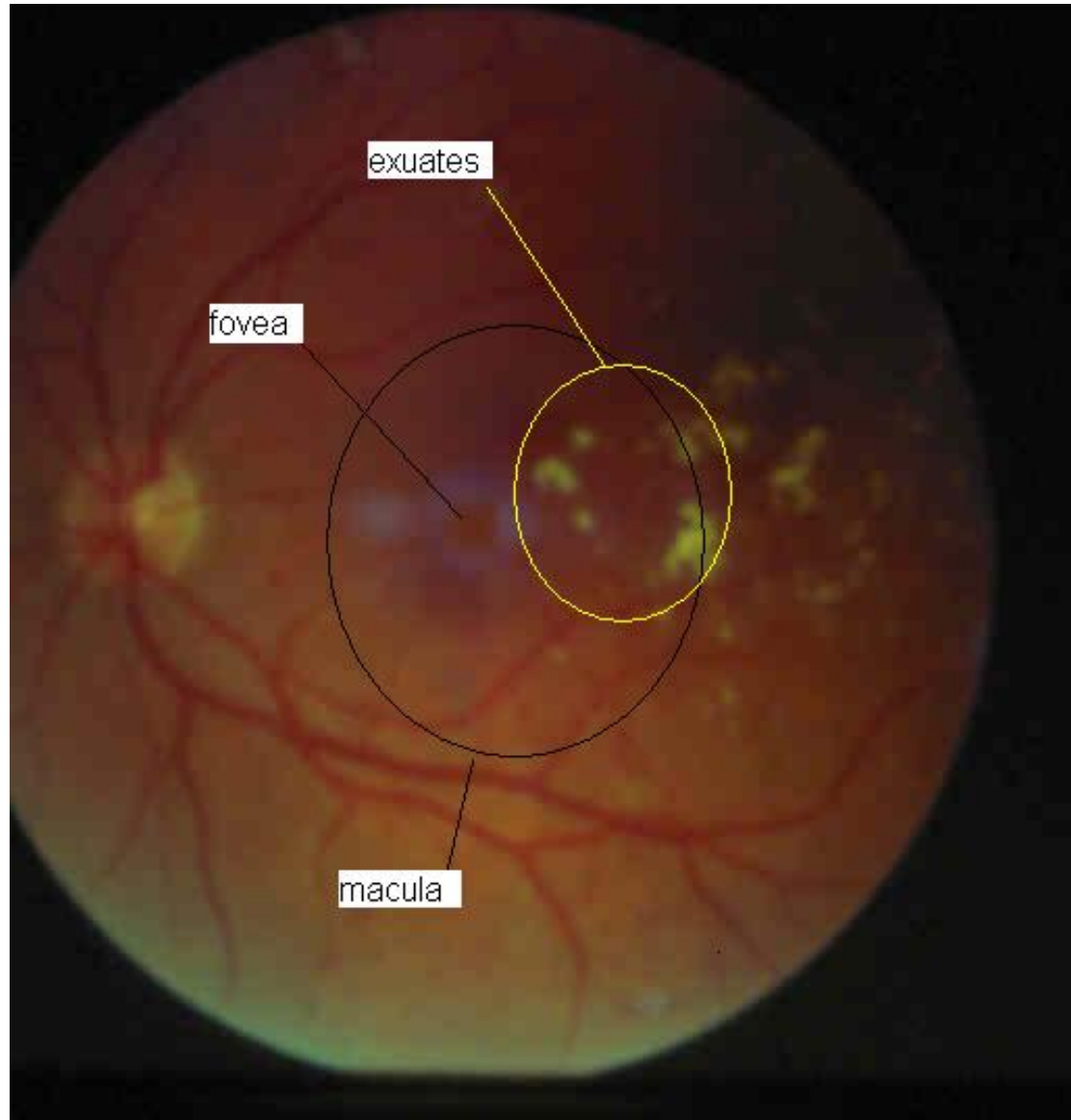
BDR



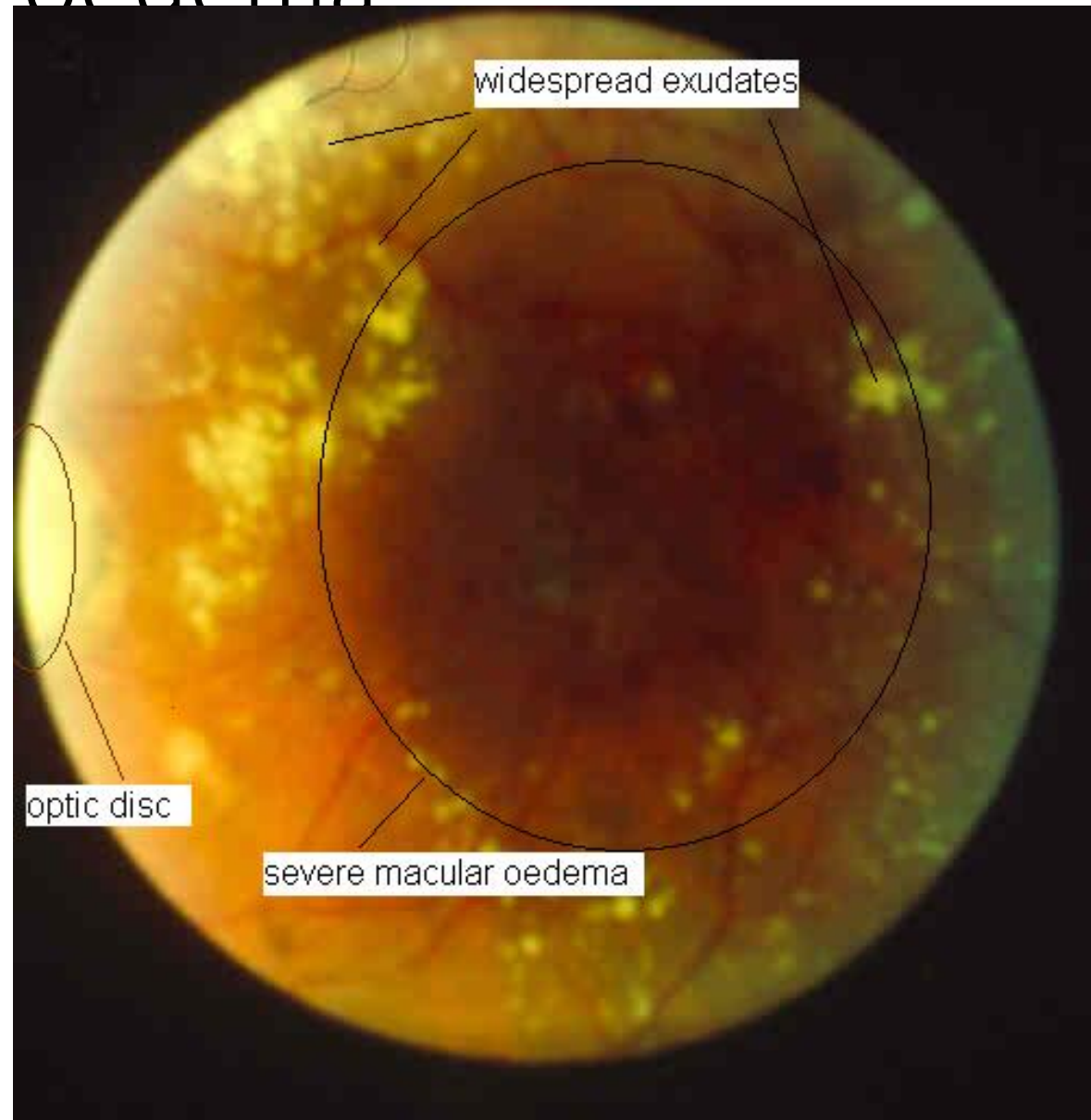
Diabetic macular oedema

- Loss of vision in BDR is due to macular oedema (CSMO)
- Signs of CSMO are:
 - Retinal thickening
 - Exudates approaching fovea
 - Focal oedema-exudates, microaneurysms
 - Diffuse oedema

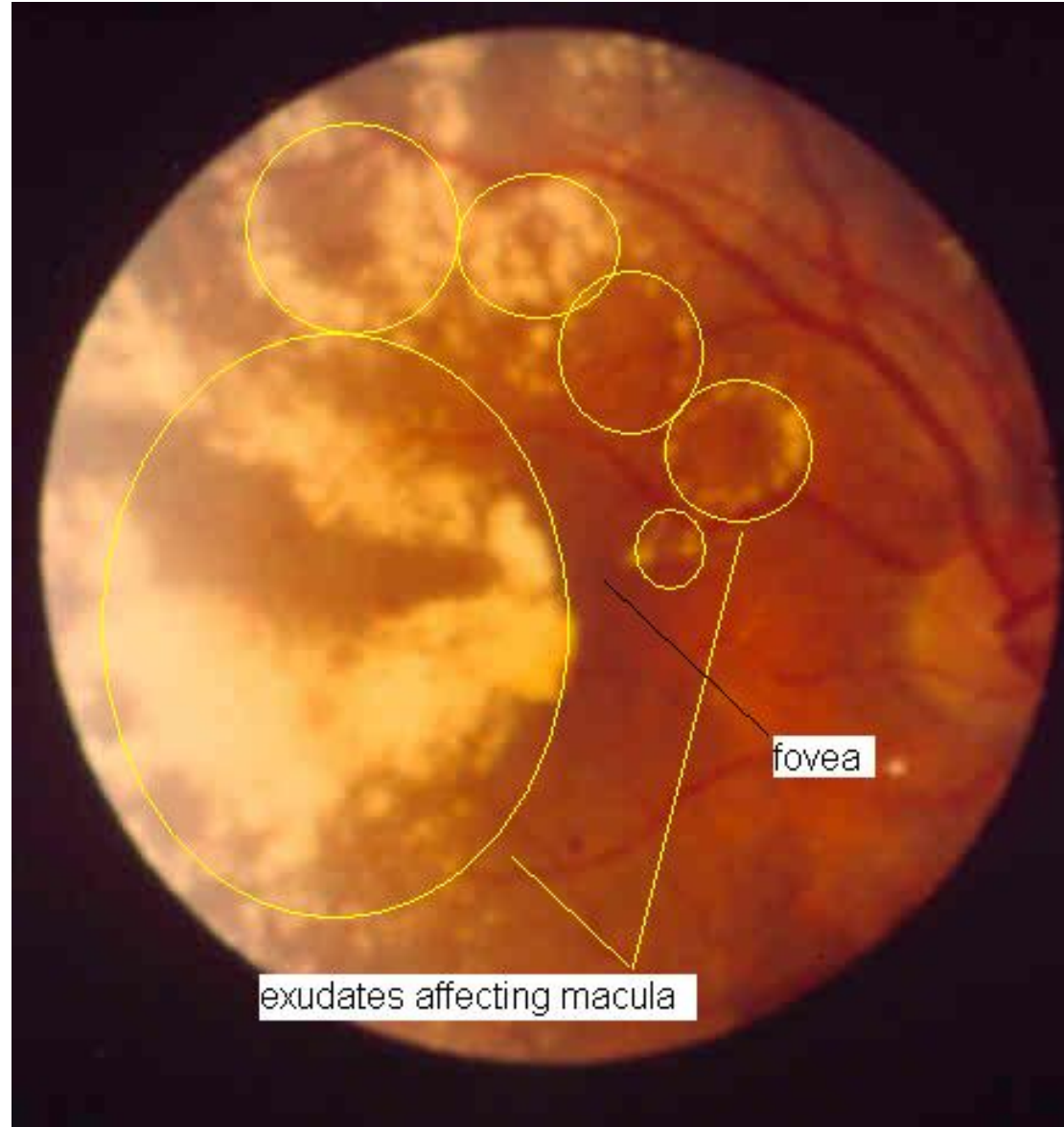
Macular oedema



Macular oedema



Macular oedema



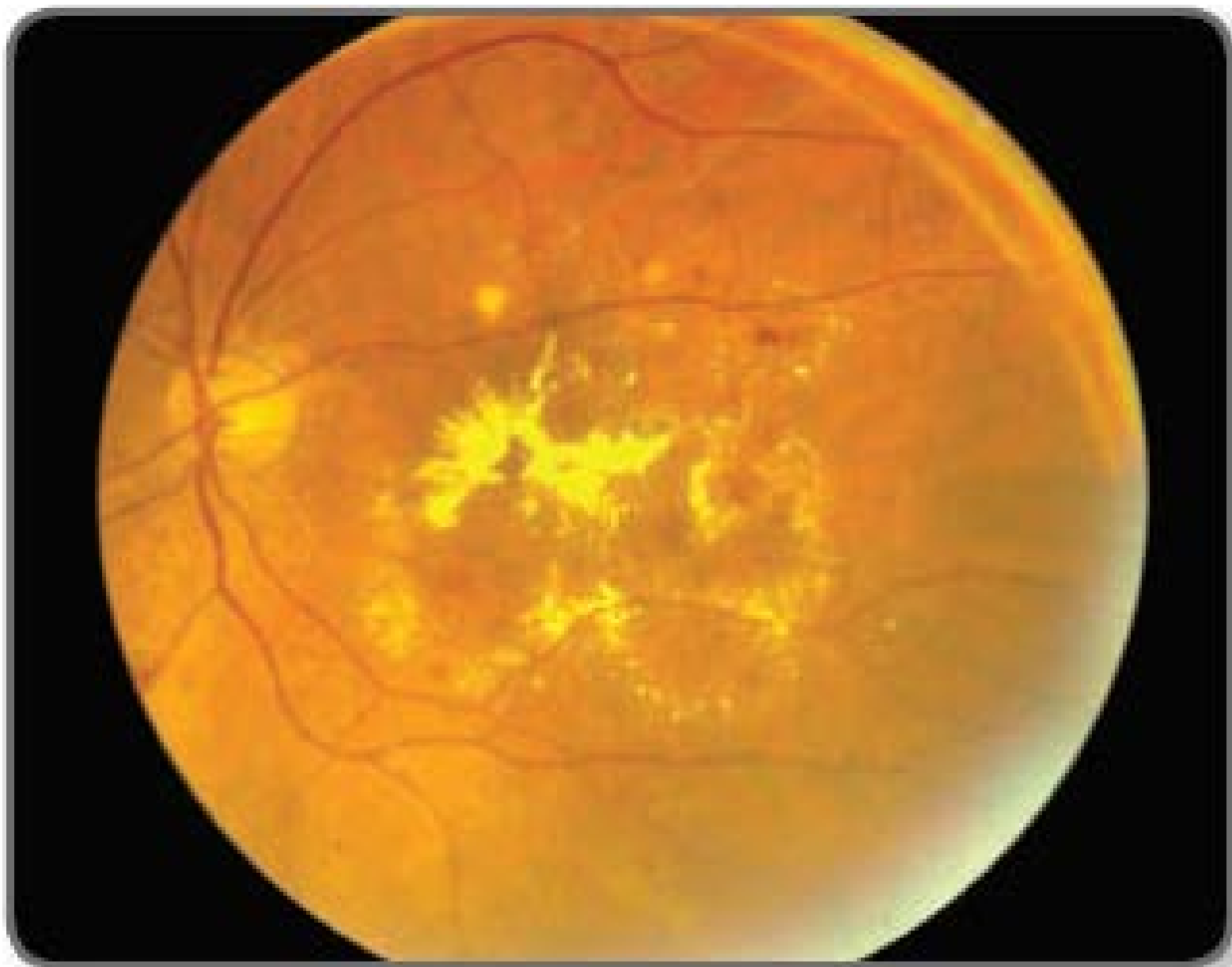
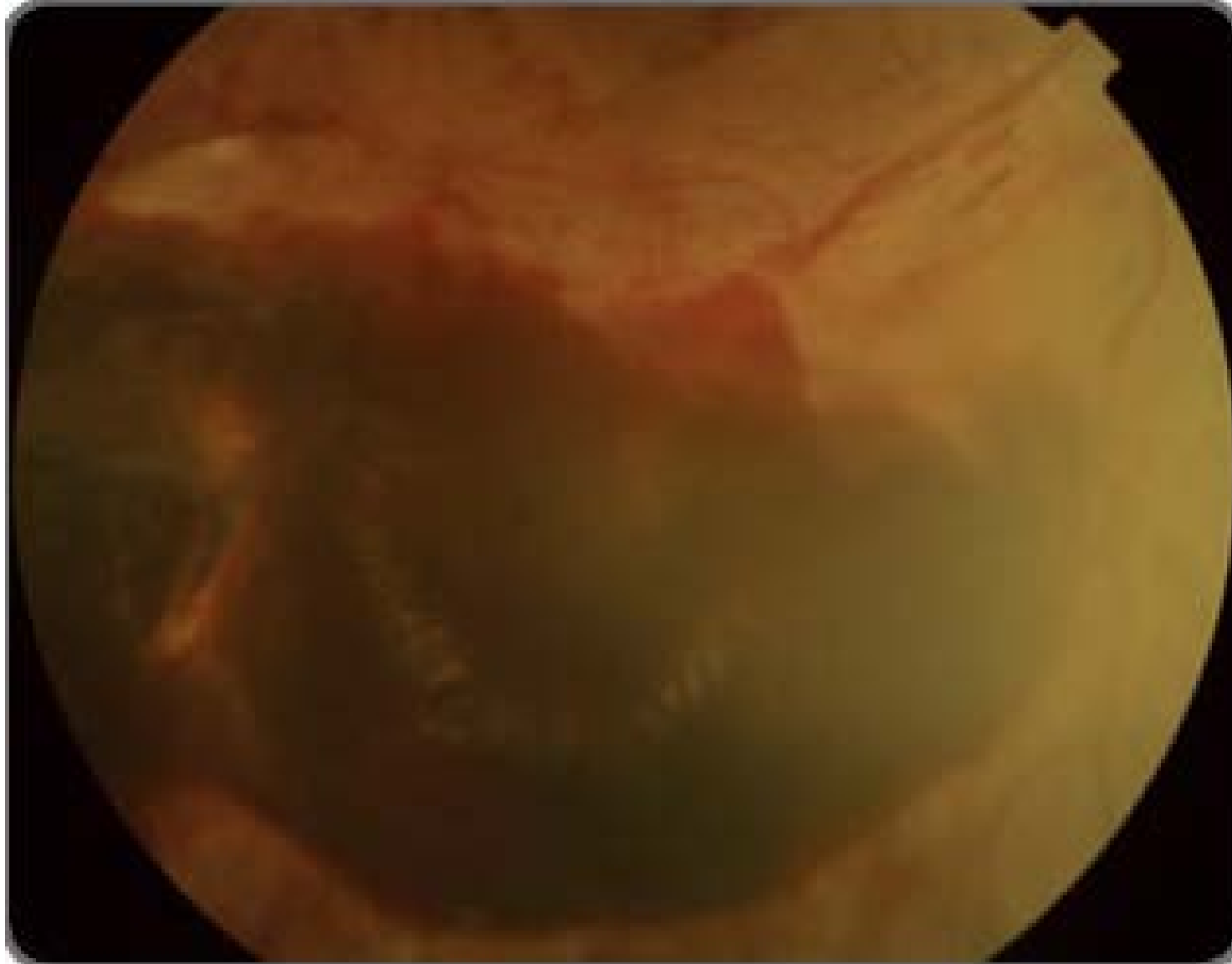


Figure 13.14 Diabetic macular exudate.

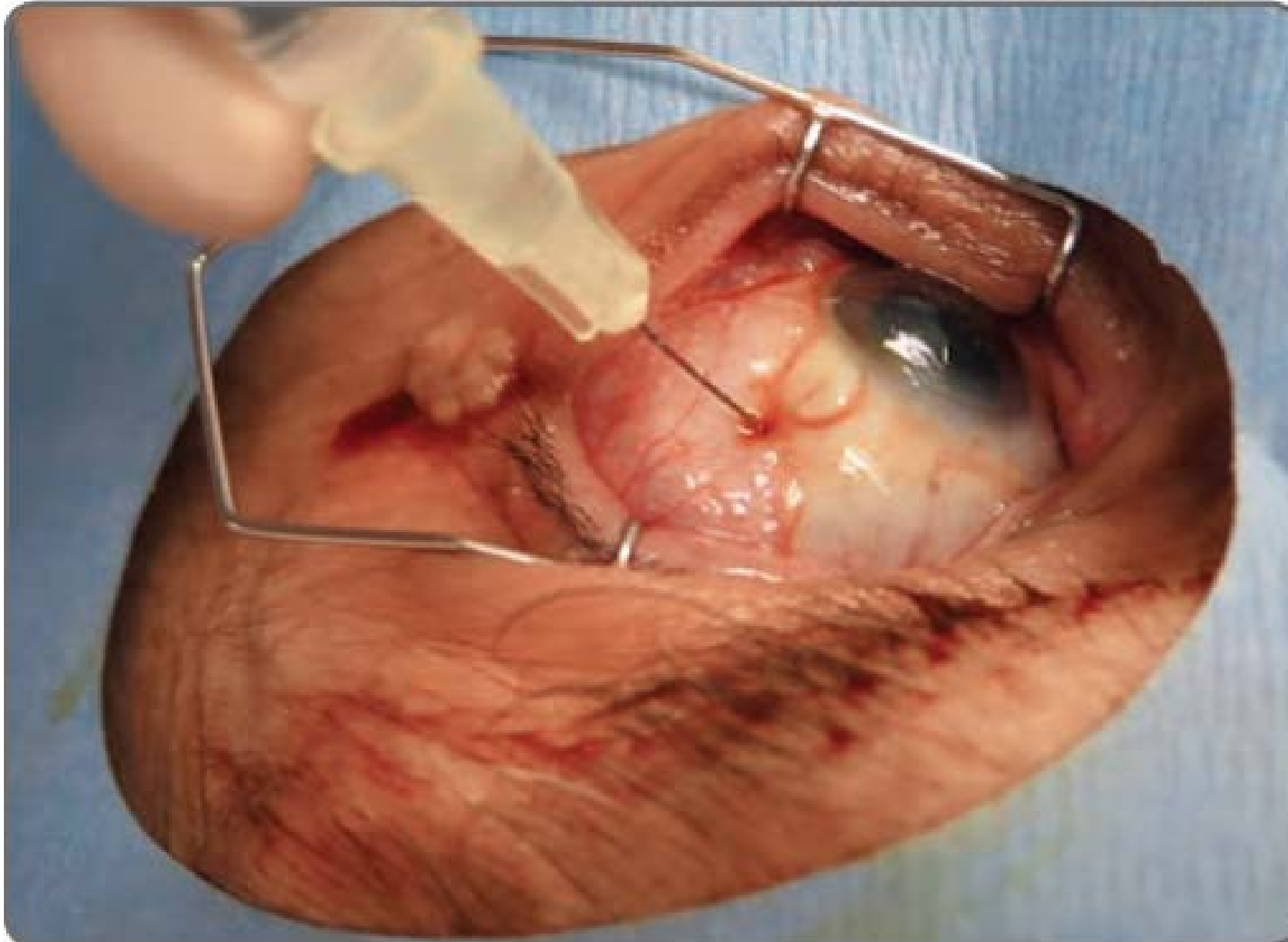


Pre-retinal haemorrhage. This bleed has come from diabetic new vessels.

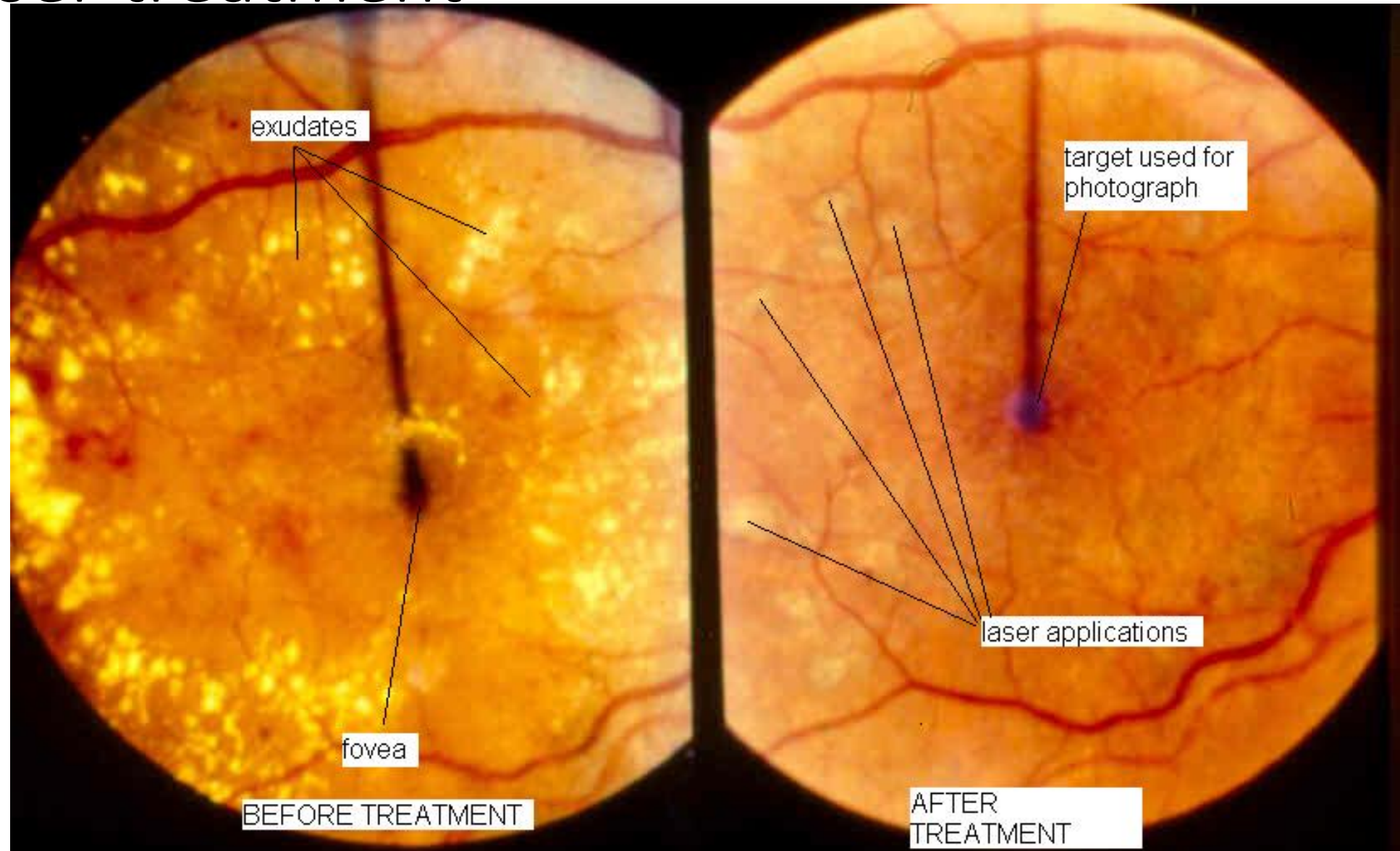
Laser treatment for macular oedema

- Oedema is caused by leaking vessels
- Laser destroys the leaking vessels
- We use small numbers of laser applications using green light argon laser
- Treatment is directed at leaking microaneurysms in the centre of a ring of exudates
- 50 micron size, 0.1 second duration

INTRAVITREAL ANTI VEGF OR TRIAMCINOLONE INJECTION



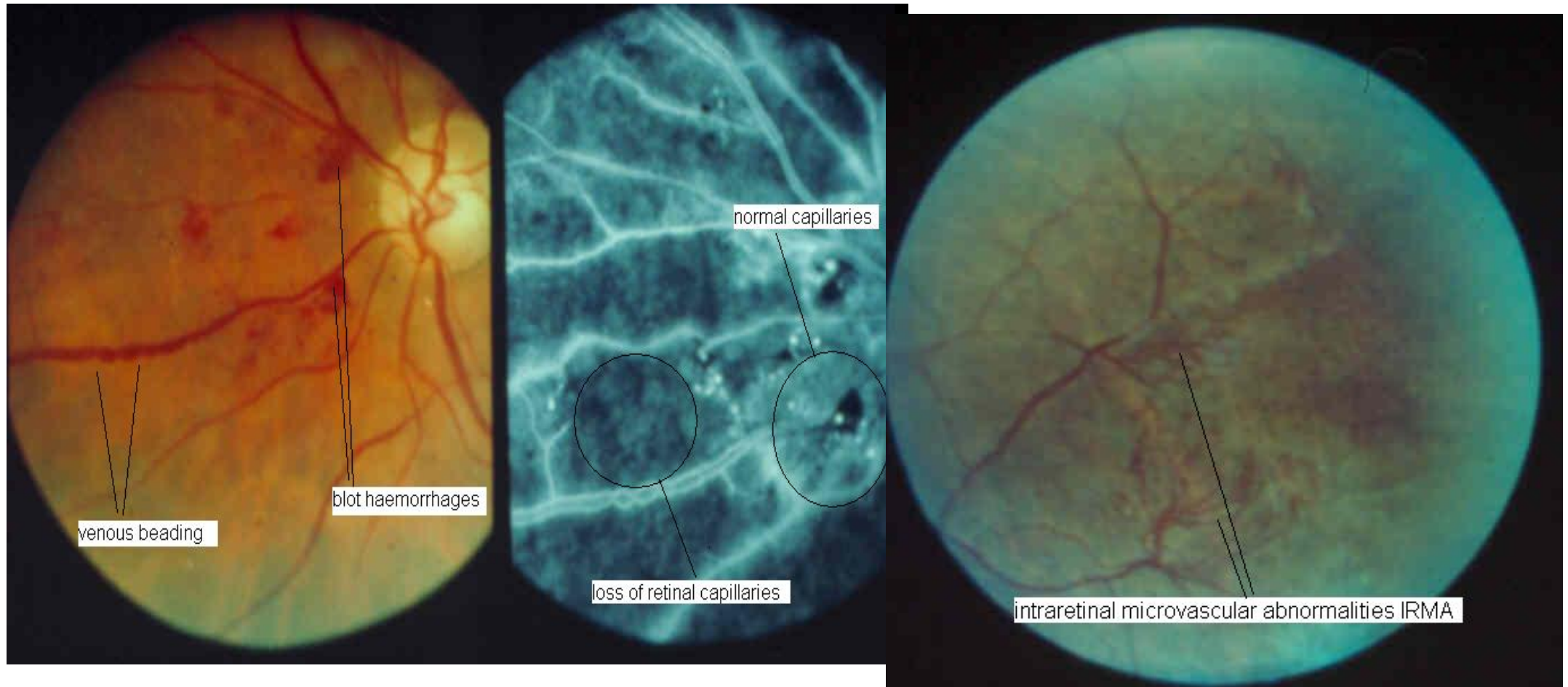
Laser treatment



Signs that background DR is progressing to proliferative DR

- Diffuse intra-retinal haemorrhages and microaneurysms in 4 quadrants
- Venous beading in 2 quadrants
- IRMA in 1 quadrant
- Very severe BDR (defined as any 2 of the above) has 45% chance of progressing to PDR in one year

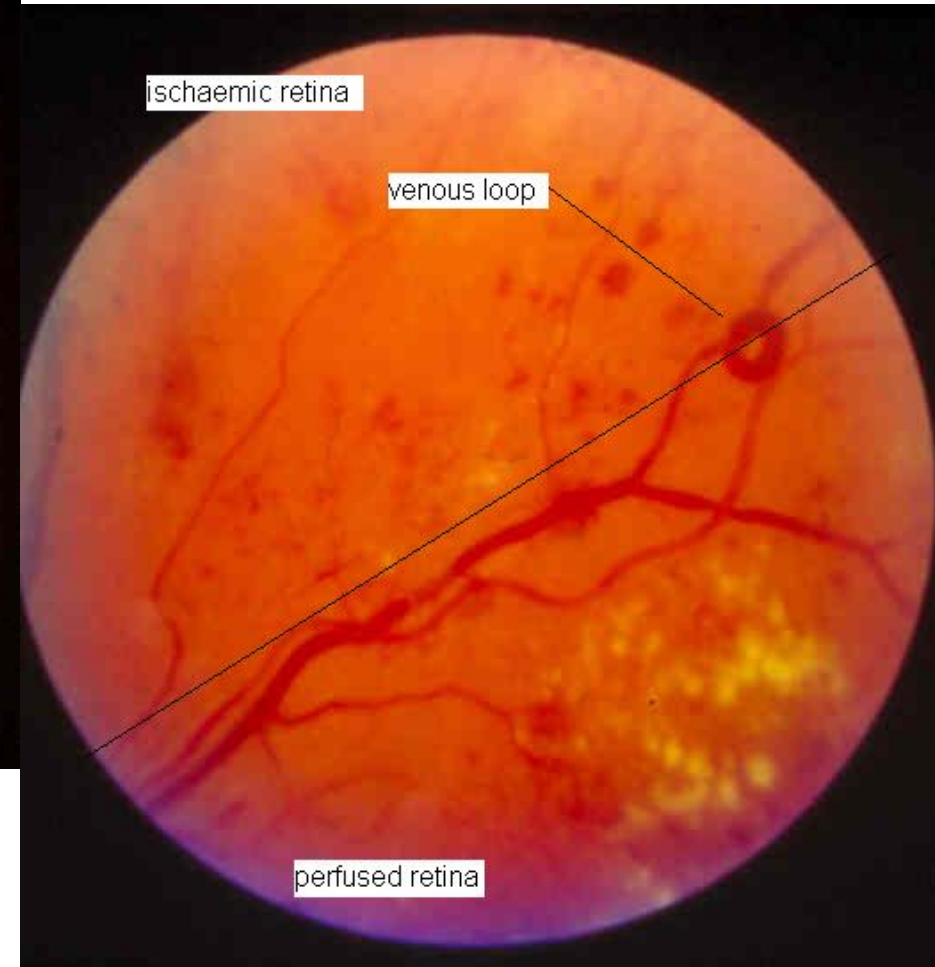
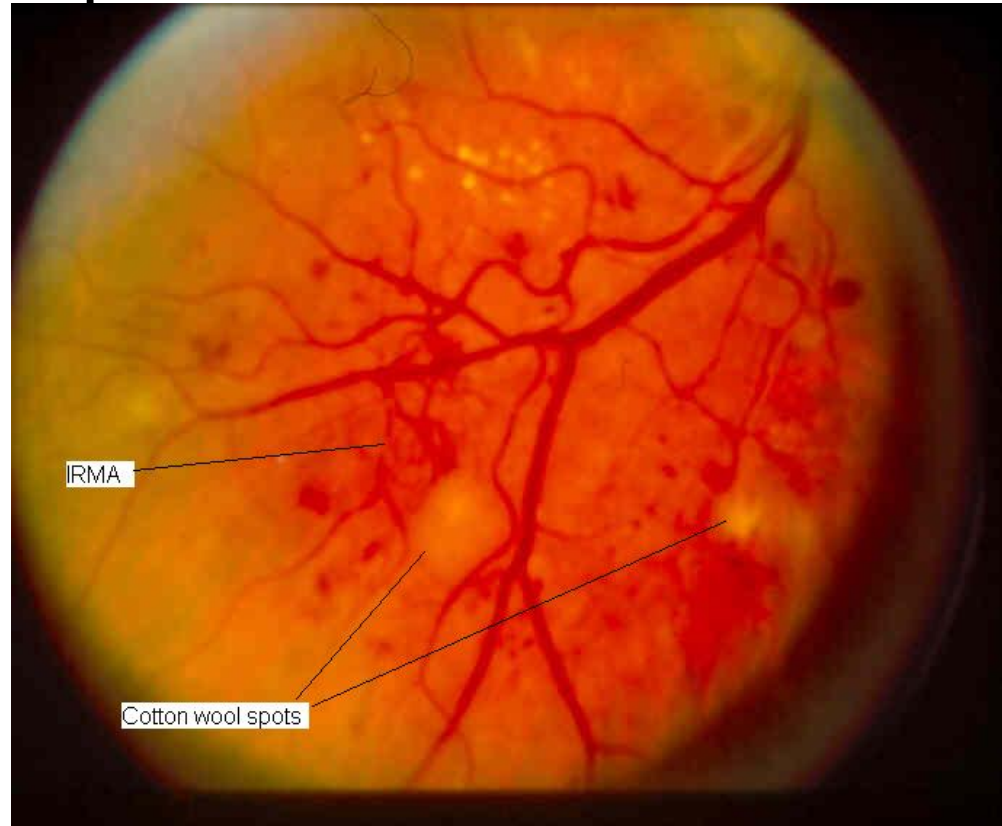
Signs that background DR is progressing to proliferative DR



Pre-proliferative DR

- Pre-proliferative DR is indicated by:
 - Severe or very severe BDR plus CWS
 - CWS indicate poor perfusion and ischaemia
 - Indicates that other clinical signs of progression should be looked for
- Patient is at high risk of developing PDR and should be reviewed more frequently or offered laser treatment

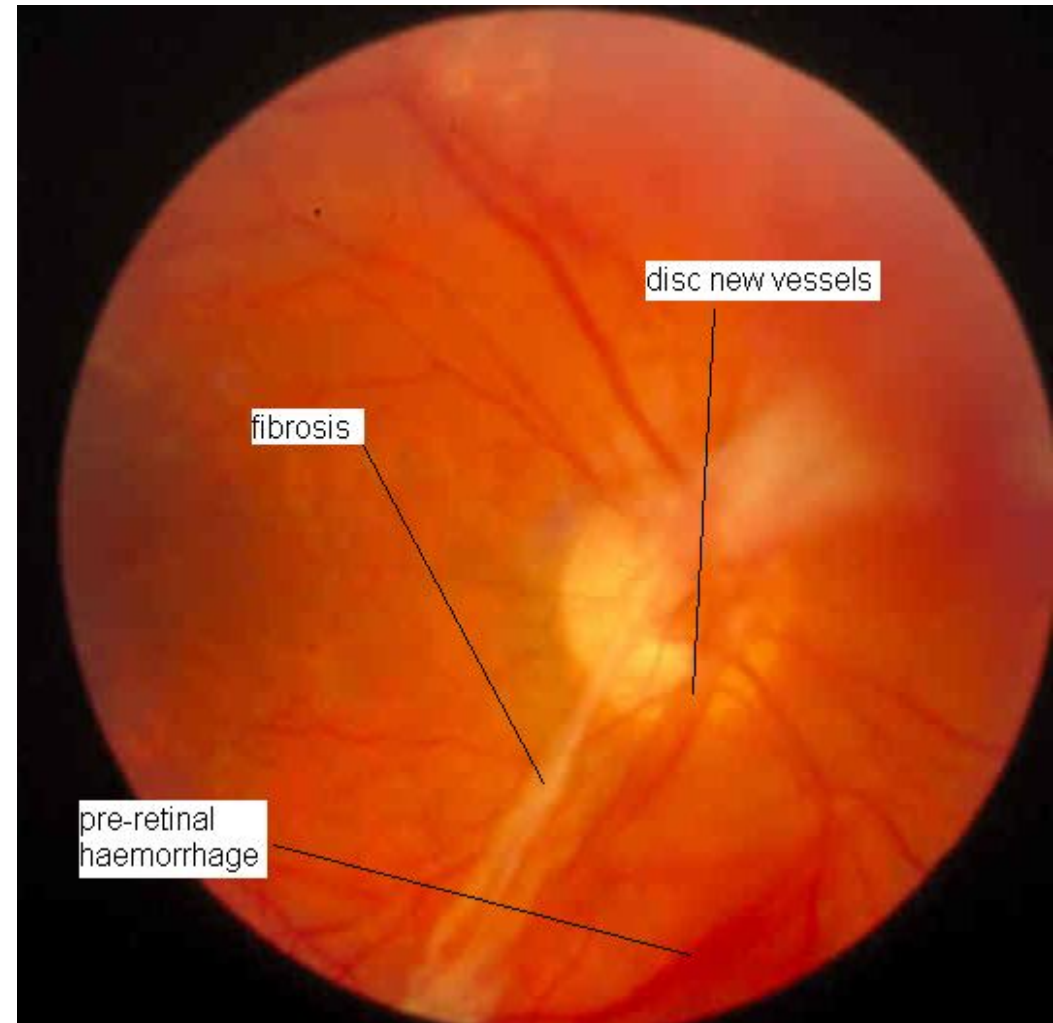
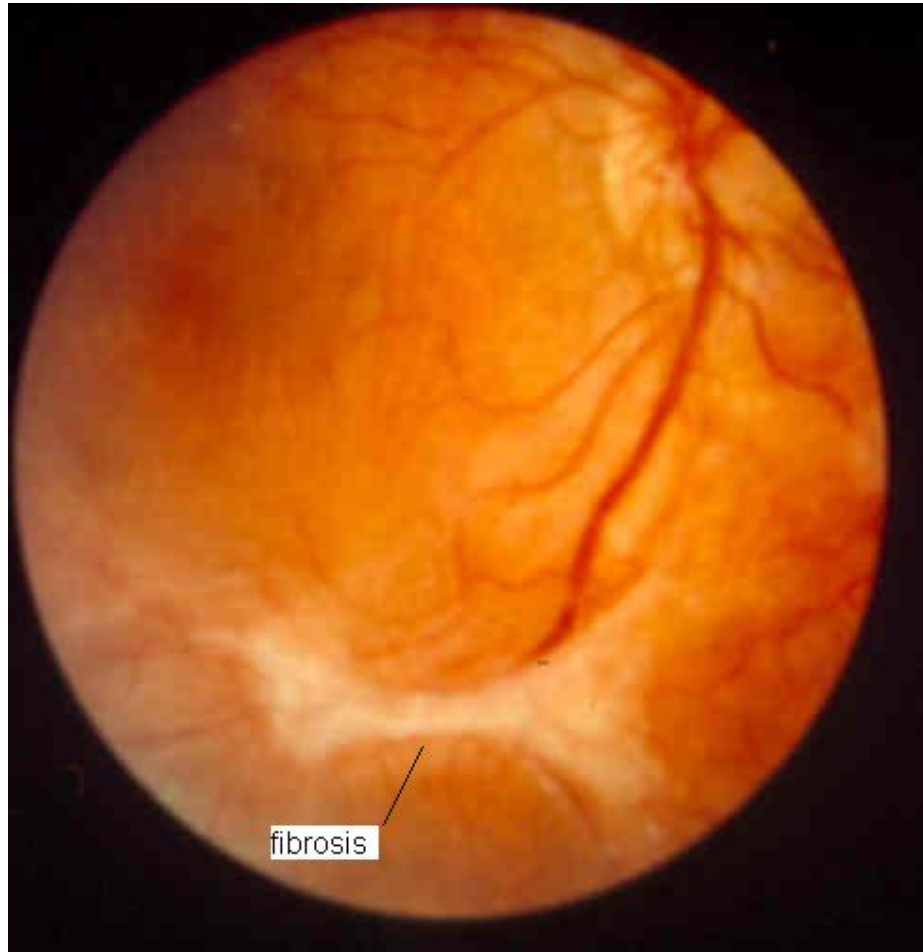
Pre-proliferative DR



Proliferative DR

- Characterised by:
 - Pre-retinal fibrovascular proliferation
- Begins with:
 - Fine new vessels (NV) with little fibrous tissue
 - These increase in size and develop fibrosis
 - Later regression of NV with fibrosis along back surface of the vitreous

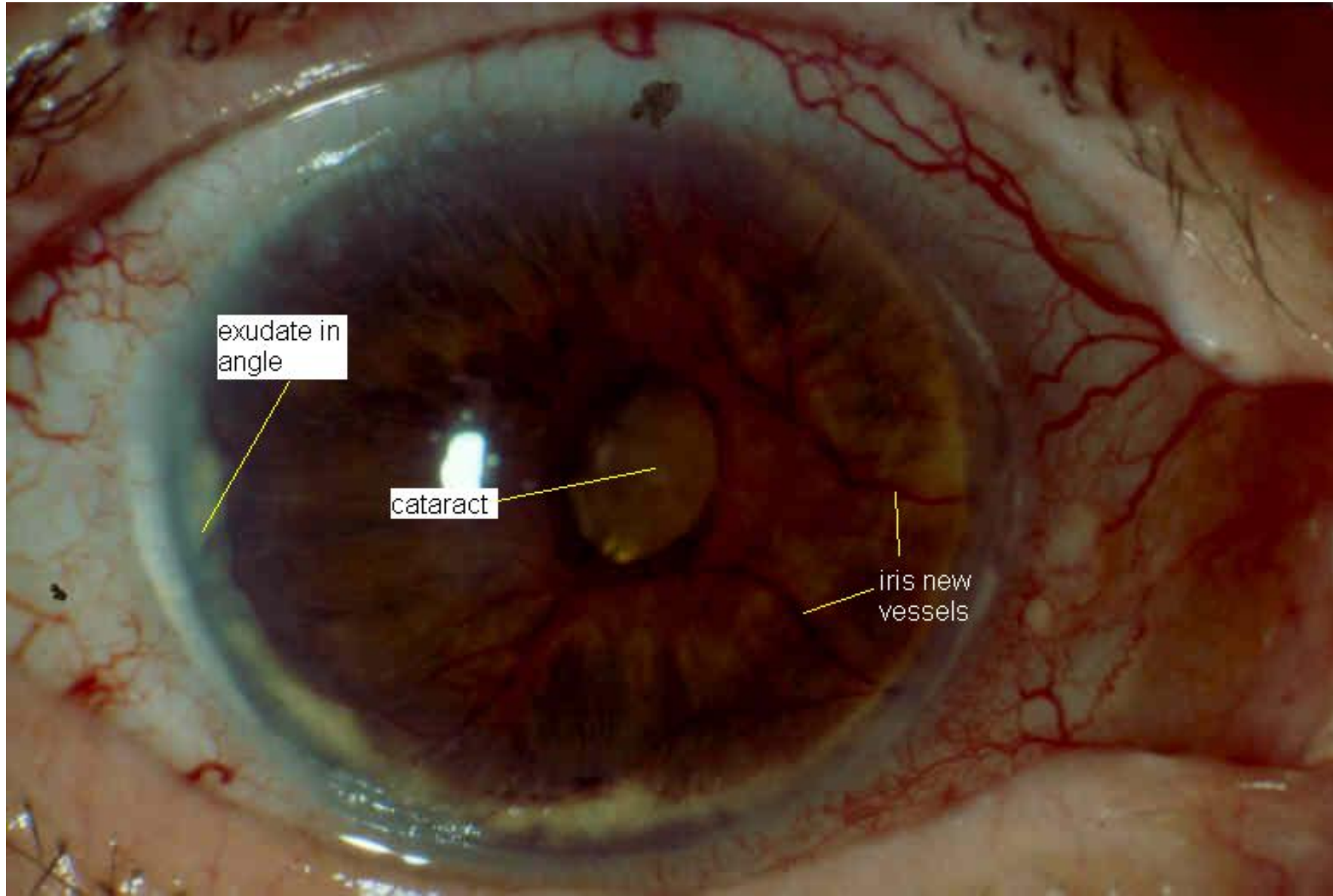
Proliferative DR



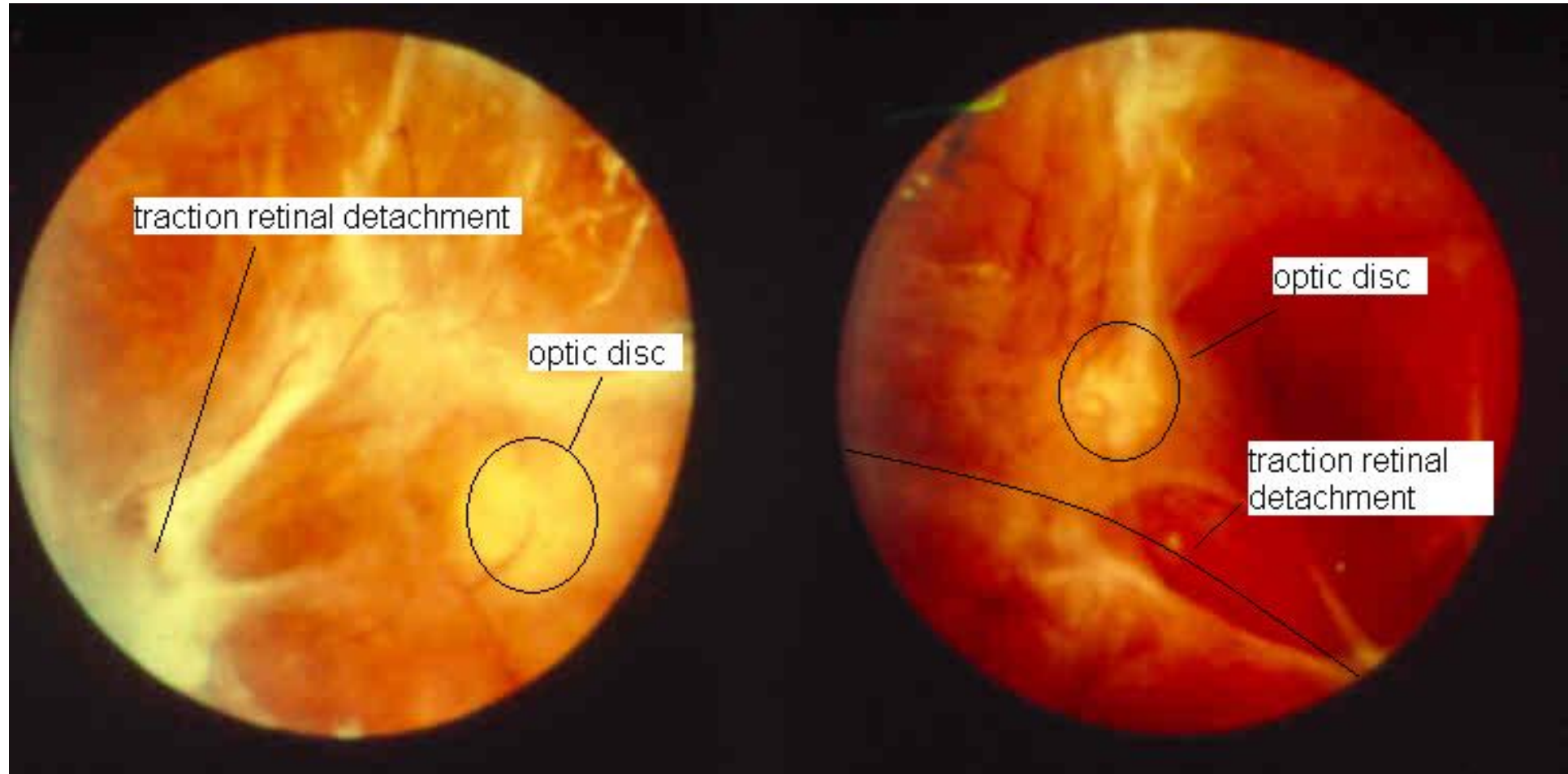
PDR

- Problems are caused by traction of vitreous on fibrovascular complexes
- This leads to
 - Pre-retinal haemorrhage
 - Vitreous haemorrhage (sudden loss of vision)
 - Retinal detachment
- Iris and angle NV cause secondary rubeotic glaucoma (very high intraocular pressure)

Iris new vessels



PDR



Tractional retinal detachment. The retina is being lifted away from the back of the eye by the traction in the vitreous.



Treatment for new vessels

- NV are caused by retinal ischaemia
- Retinal oxygen demand exceeds oxygen supply
- Scatter laser treatment (Pan Retinal Photocoagulation-PRP) reduces oxygen demand by destroying retinal tissue in a controlled way
- Typically 1200 to 5000 applications
- Side effects include
 - field loss (problems for drivers)
 - macular oedema (loss of visual acuity)

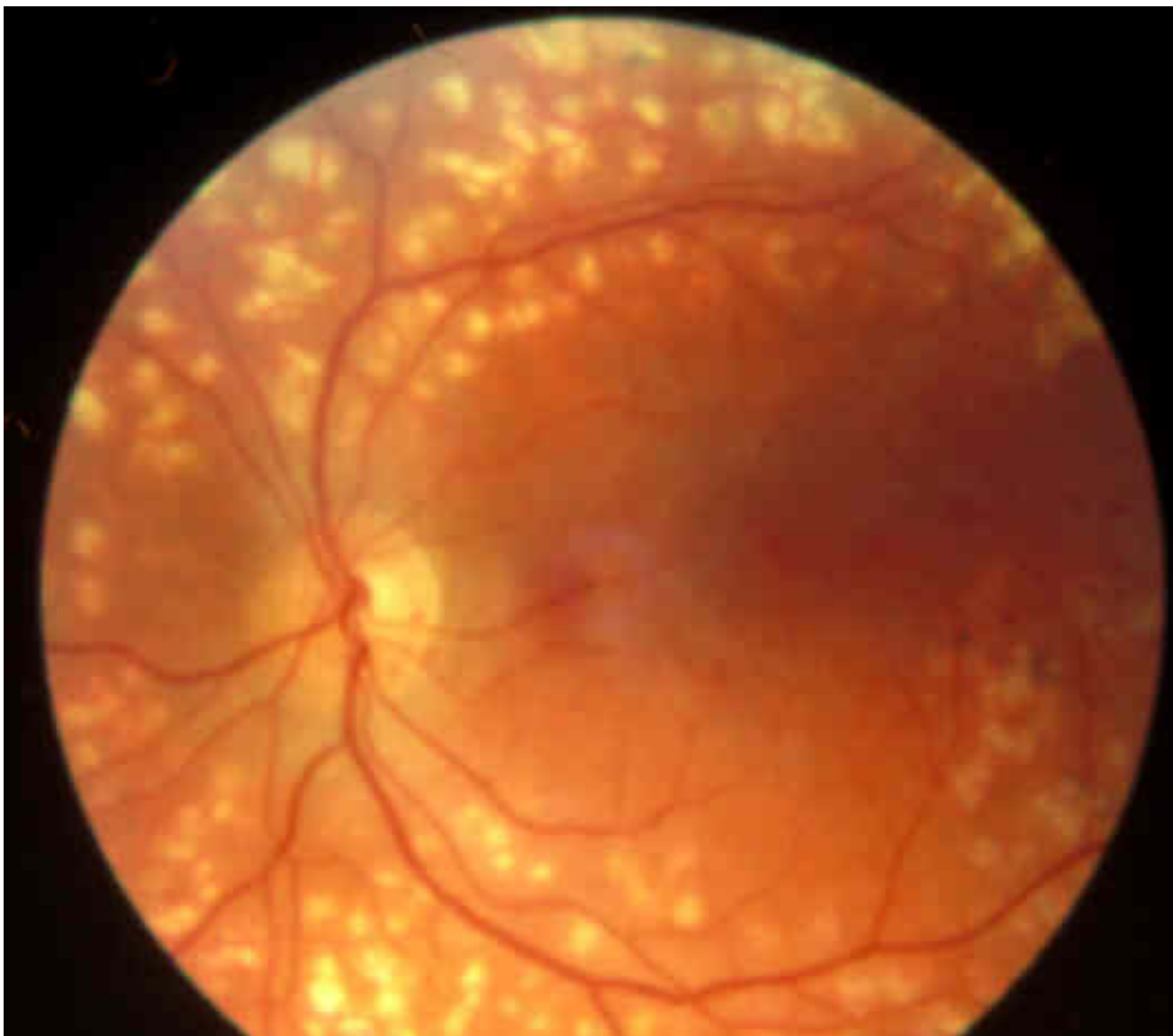
Vitrectomy

- Vitrectomy can be an essential vision saving operation in patients with persistent vitreous haemorrhage.
- The patient is also suspected of having active proliferative retinopathy, which cannot be seen behind the blood. Vitrectomy clears the haemorrhage so that the PRP can be done.
- The patient is suspected of having vitreous scarring and traction that is threatening to cause a retinal detachment. Vitrectomy allows the retina to be released and lasered to repair and prevent further detachment.

Treatment for PDR



Typical appearance after successful treatment



Screening for DR

- If onset of diabetes is <30 years of age, examine retina within 5 years of diagnosis and review annually
- If onset of diabetes is >30 years of age, examine retina at diagnosis and then annually
- During pregnancy, the retina should be examined once during every trimester

Diabetic Retinopathy Management

| Condition | Action |
|---|--|
| Minimal or Mild Background DR Low risk Background DR | Routine Care Recall for annual review |
| Occurrence/worsening of lesions since previous assessment Scattered exudates >1DD from fovea People at high risk of progression <ul style="list-style-type: none">•Sudden improvement in glycaemic control•Renal disease•Hypertension | Early Review Recall and review every 3 - 6 months |
| Unexplained drop in VA Hard exudates within 1DD of fovea Macular oedema Unexplained retinal findings Pre-proliferative or severe DR | Referral Ophthalmologist within 4 weeks |
| New vessels Pre-retinal and/or vitreous haemorrhage Rubeosis Iridis | Urgent Referral Ophthalmologist within 1 week |
| Sudden loss of vision Retinal detachment | Emergency Referral Ophthalmologist same day |

Preventing blindness from diabetic retinopathy

- All diabetics should understand how important it is to look after their bodies and must be helped and reminded of the following:
- Keep the blood sugar controlled. Patients should be taught how to supervise their own diabetic medication to keep the blood glucose level normal throughout the day.
- Keep the blood pressure controlled: aim for less than 140/80 mmHg.
- Keep to a strict, healthy diet and avoid obesity.
- Take exercise regularly.
- Avoid smoking.
- REGULAR SCREENING FOR DIABETIC RETINOPATHY

REFERENCES

- Global and regional diabetes prevalence estimates for 2019 and projections for 2030 and 2045: Results from the International Diabetes Federation Diabetes Atlas, 9th edition, Pouya Saeedi, Inga Petersohn, Paraskevi Salpea, Dominic Bright, Rhys Williams
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Questions???



POP QUIZ!!!

QUIZ #1 True or False?

- People with diabetes are more likely than people without diabetes to develop certain eye diseases.
- **True.** Diabetic eye disease includes diabetic retinopathy—a leading cause of blindness in adults—cataract, and glaucoma. The longer someone has diabetes, the more likely he or she will develop diabetic eye disease.

#2 True or False

- Diabetic eye disease usually has early warning signs.
- **False.** Often there are none in the early stages of the disease. Vision may not change until the disease becomes severe.

#3 True or False

- People with diabetes should have yearly eye examinations.
- **True.** Everyone with diabetes should get an eye examination through dilated pupils at least once a year. Because diabetic eye disease usually has no symptoms, regular eye exams are important for early detection and timely treatment.

#4 True or False

- Diabetic retinopathy is caused by changes in the blood vessels in the eye.
- **True.** In some people, blood vessels in the retina may swell and leak fluid. In other people, abnormal new blood vessels grow on the surface of the retina.

#5 True or False

- People with diabetes are at low risk for developing glaucoma.
- **False.** Glaucoma is almost twice as likely to occur in people with diabetes than in those without the disease. Glaucoma can usually be treated with medications or laser or other surgery.

#6 True or False

- Laser surgery can be used to halt the progression of diabetic retinopathy.
- **True.** In laser surgery, a special beam of light is used to shrink the abnormal blood vessels or seal leaking blood vessels. Laser surgery has been proved to reduce the five-year risk of vision loss from advanced diabetic retinopathy by more than 90 percent.

#7 True or False

- People with diabetes should have regular eye examinations through dilated pupils.
- **True.** An eye examination through dilated pupils is the best way to detect diabetic eye disease, in which drops are used to enlarge the pupils. This allows the eye care professional to see more of the inside of the eye to check for signs of the disease.

#8 True or False

- Cataracts are common among people with diabetes.
- **True.** People with diabetes are twice as likely to develop cataracts and to develop them at an earlier age than are those without diabetes. Cataracts can usually be treated with surgery.

#9 True or False

- People who have good control of their diabetes are not at high risk for diabetic eye disease.
- **False.** Even with good control of blood glucose, there is still a risk of developing diabetic eye disease. However, studies show that careful management of blood sugar levels slows the onset and progression of diabetic retinopathy.

#10-- True or False

- The risk of blindness from diabetic eye disease can be reduced.
- True.** With early detection and timely treatment, the risk of blindness from diabetic eye disease can be reduced.

THANK YOU